HIRDLS Observations of Subvisible Cirrus

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Motivation

NCAR

Cirrus and dehydration

Ice particles fall out of freezing air parcels, which dehydrate the upper troposphere and lower stratosphere

Cirrus is produced by

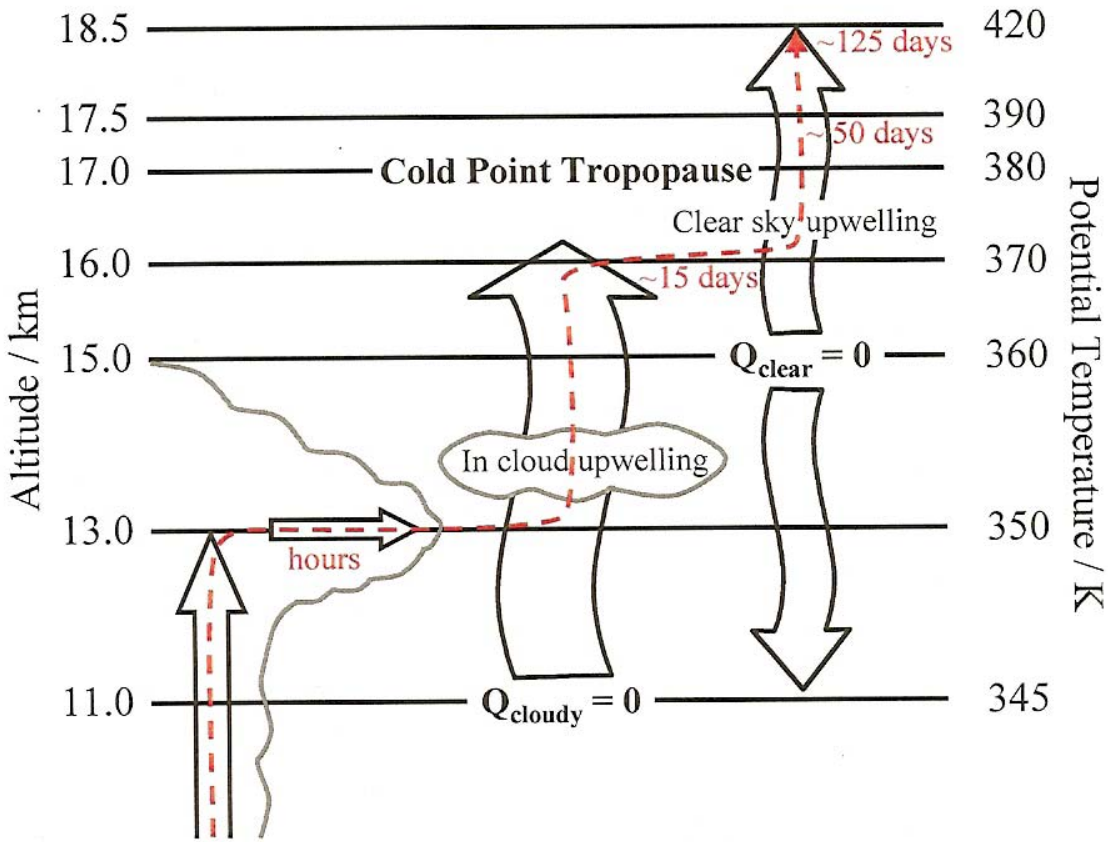
a) blow-off from deep convection

b) air parcels that freeze along vertical and horizontal trajectories

Jensen et al., A conceptual model of the dehydration of air due to freeze-drying by optically thin, laminar cirrus rising slowly across the tropical tropopause, JGR, *106*, 17237-17252, 2001.

Motivation

NCAR



Corti et al., The impact of cirrus clouds on tropical troposphere-to-stratosphere transport, Atmos. Chem. Phys., 6, 2539-2547, 2006.

Outline

NCAR

Use HIRDLS and CALIPSO data to address the following questions:

Where are cirrus layers located?

When are the layers most prevalent?

Are the layers related / unrelated to deep convection?

Data

HIRDLS February 2005 – March 2007 limb view
Cloud detection flags and preliminary extinction

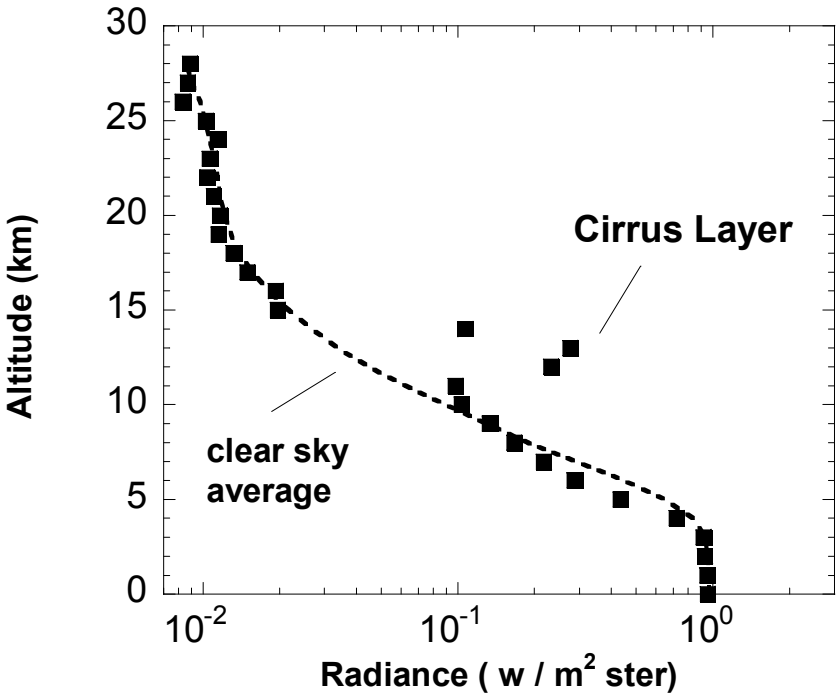
CALIPSO August 2006 – July 2007 nadir view
CAL_LID_L2_05kmCLay_Prov_V1_10 and V1_20 cloud files
Top and bottom altitude levels of the cloud layers

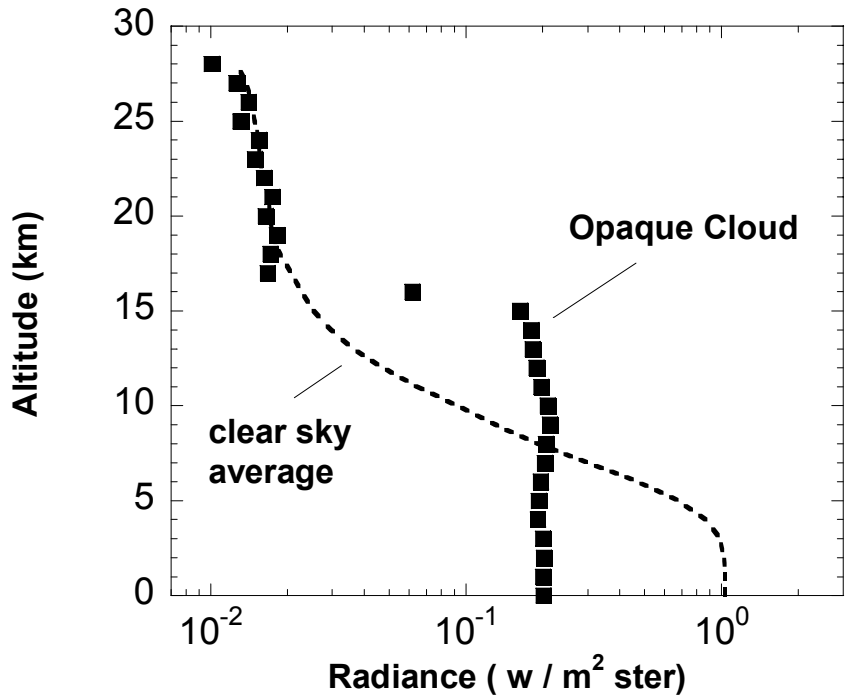
MLS limb view
RHI (relative humidity with respect to ice) data

Climate Diagnostics Center nadir view
OLR (Outgoing Longwave Radiation)

Tropical Cloud Radiance Profiles

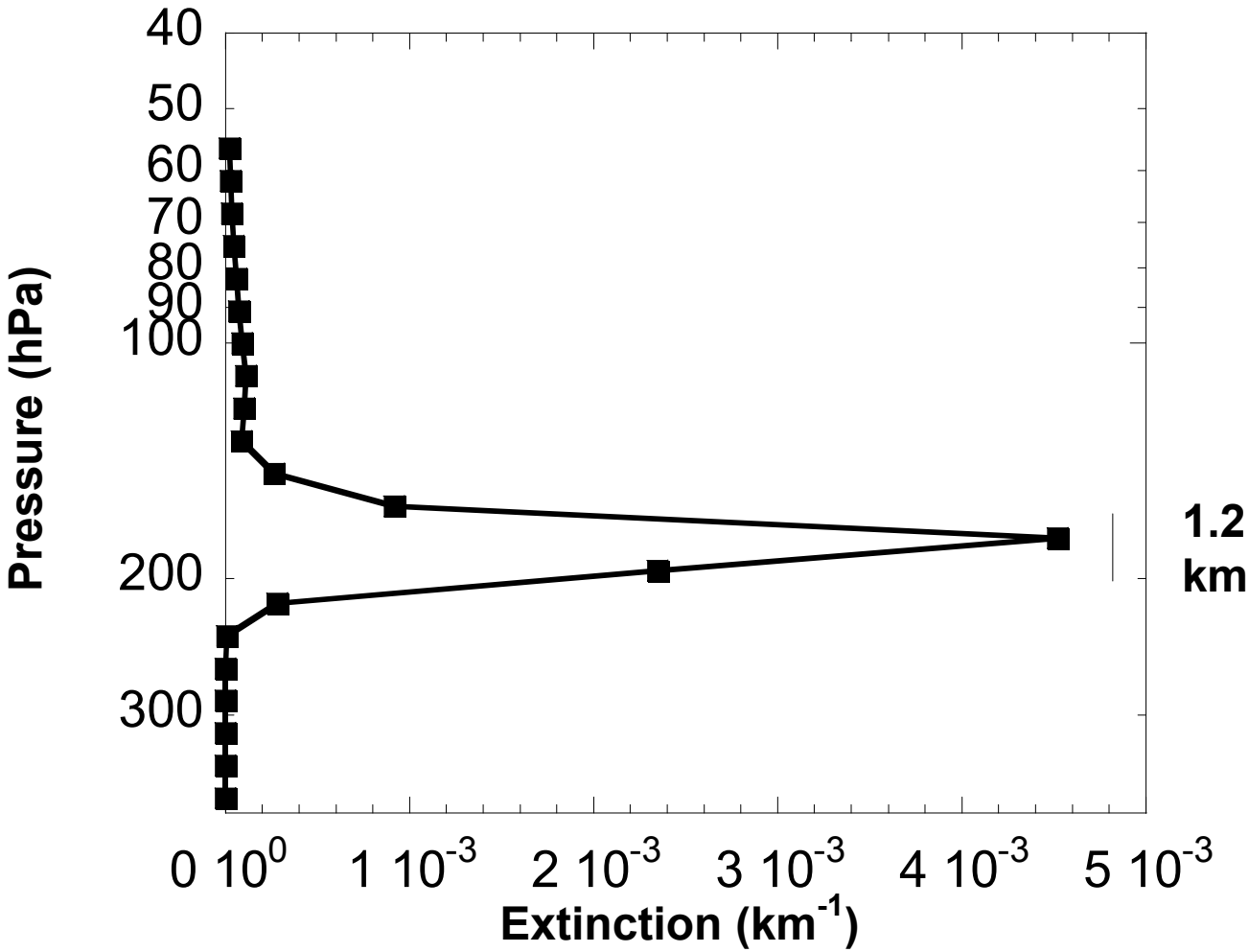
NCAR





Single 12 μm HIRDLS radiance profiles

Cirrus Layer Extinction Profile



Single 12 μm HIRDLS extinction profile

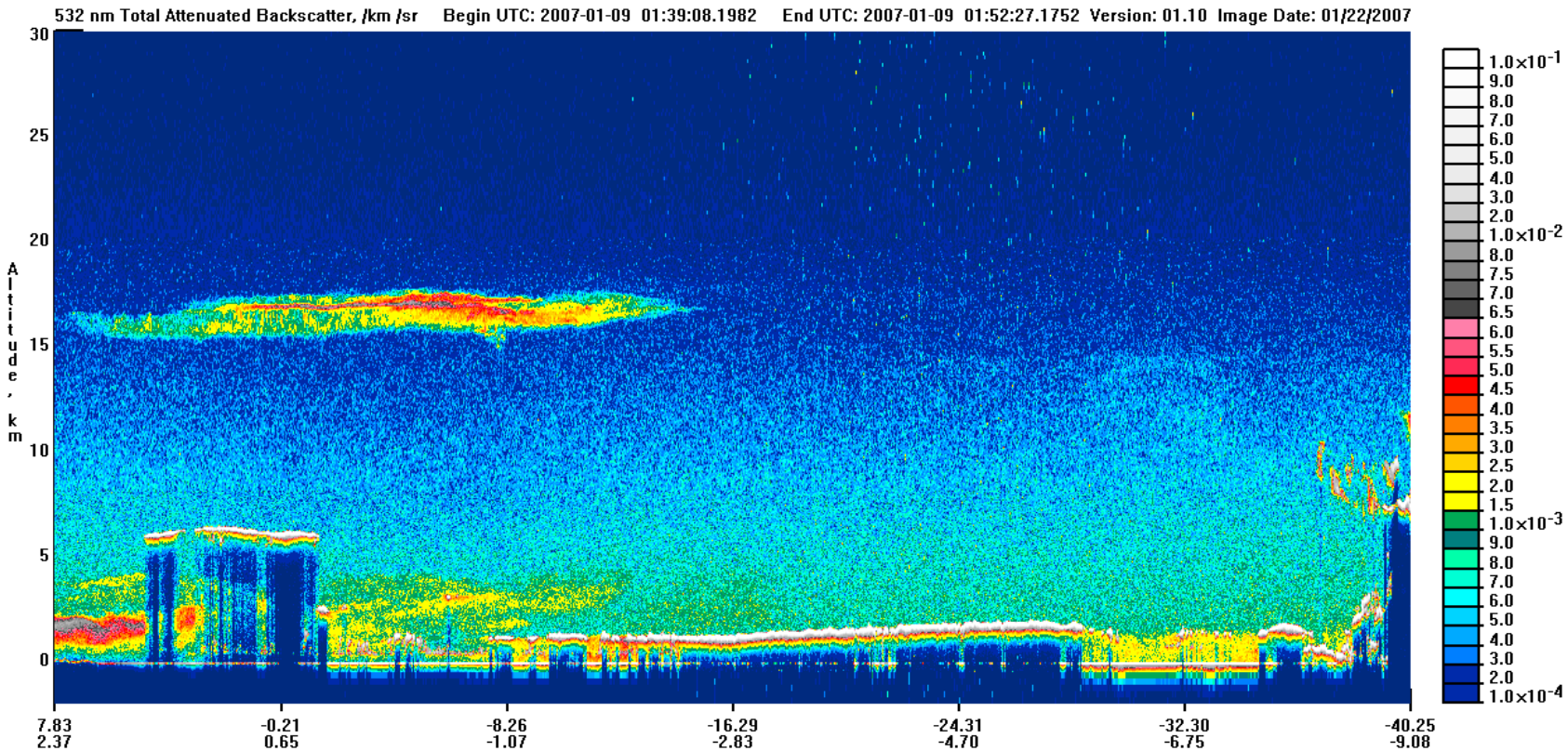
CALIPSO Observation
January 9, 2007

NCAR

30 km

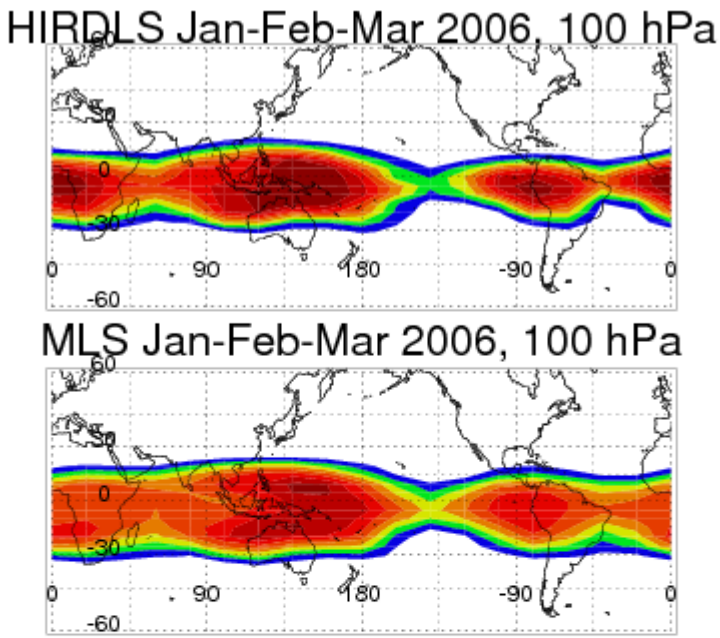
17 km

0



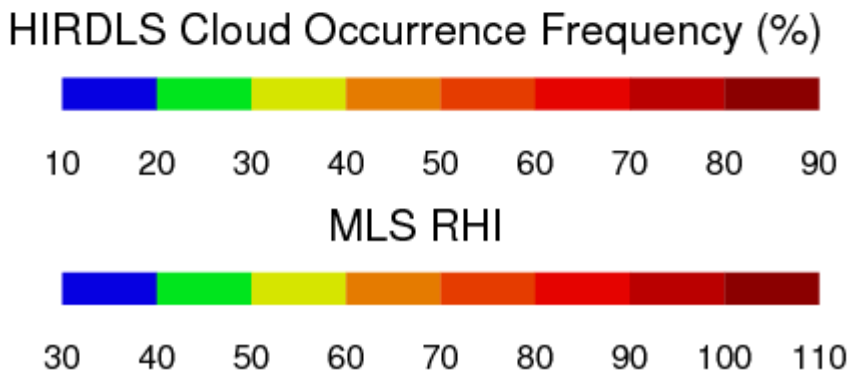
Latitude 7 0 -8 -16 -24 -32

Where are clouds seen and expected?



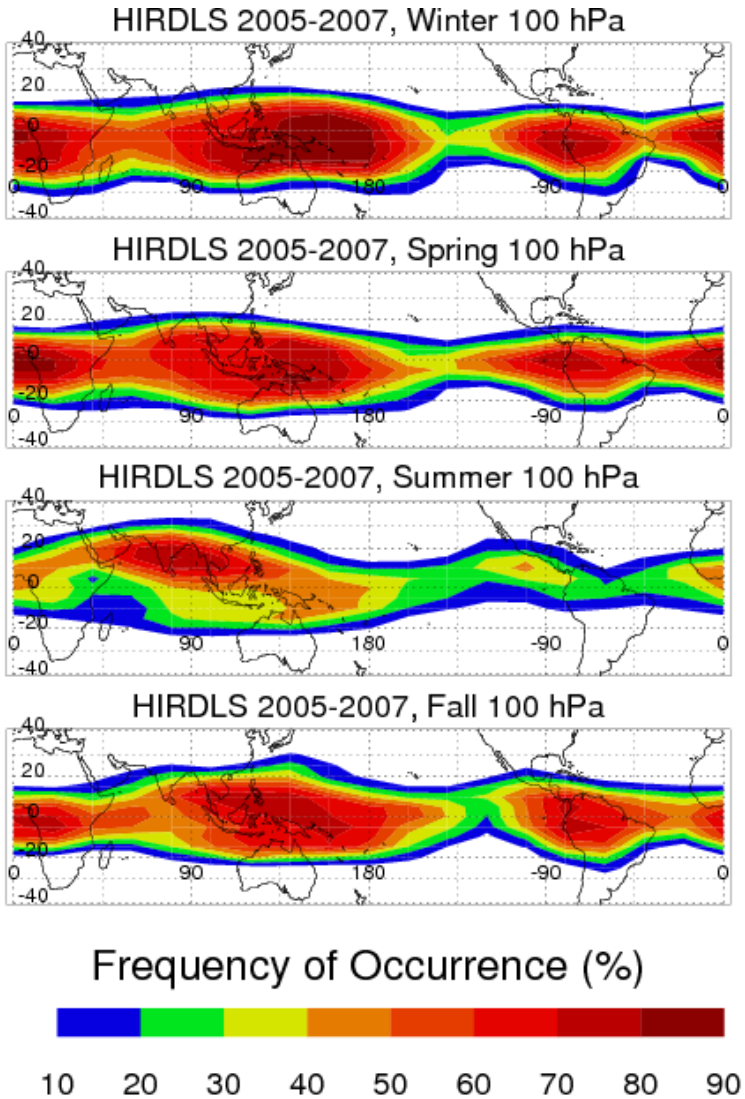
All clouds

RHI



note scale
10 – 90%

Seasonal Variation – All Clouds



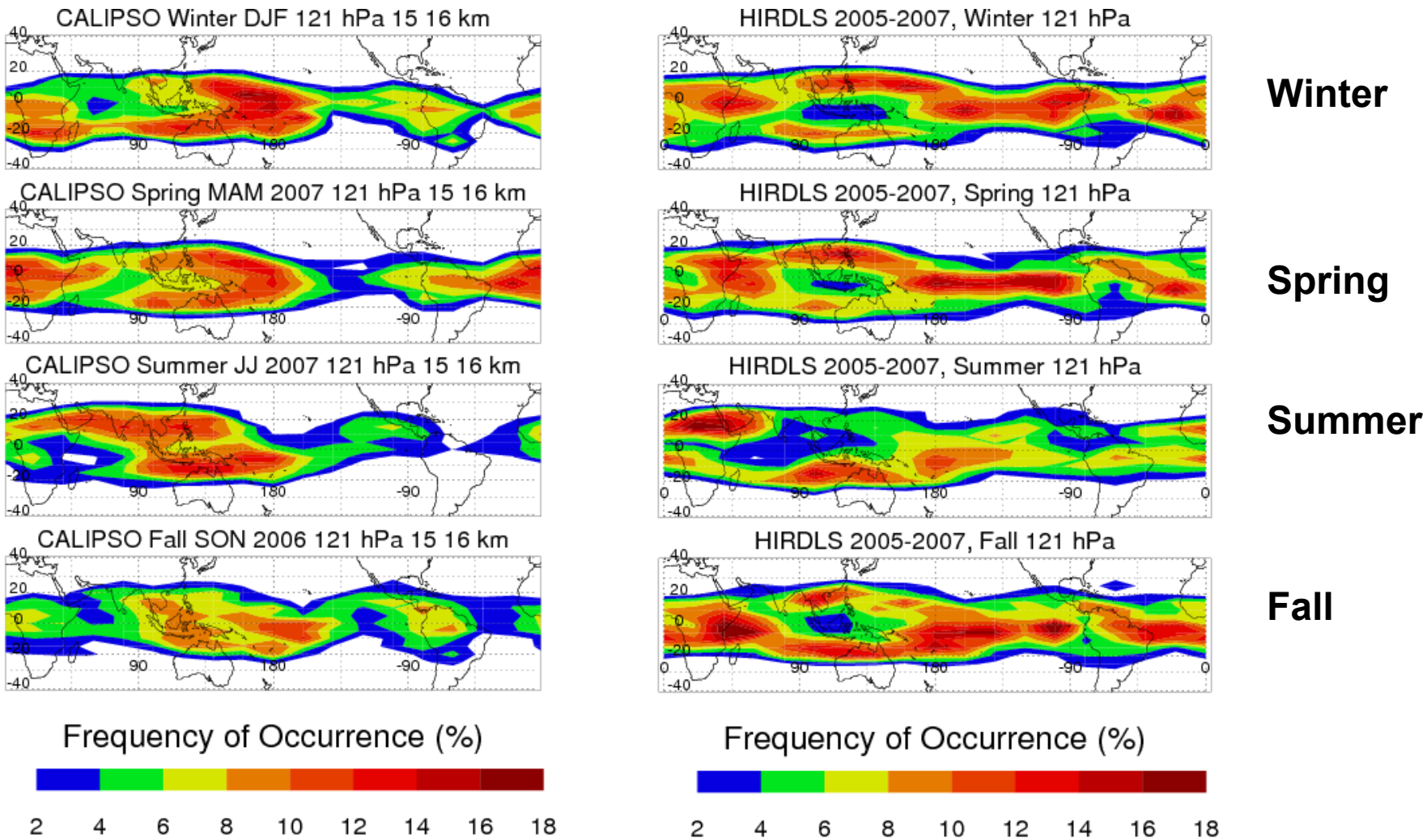
Winter

Spring

Summer

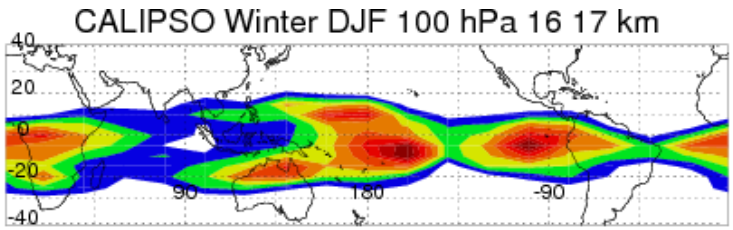
Fall

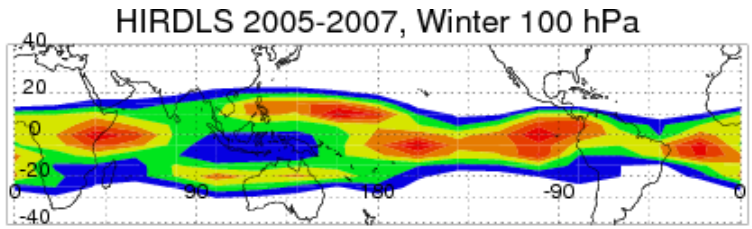
Seasonal Variations of Cirrus Layers – 121 hPa



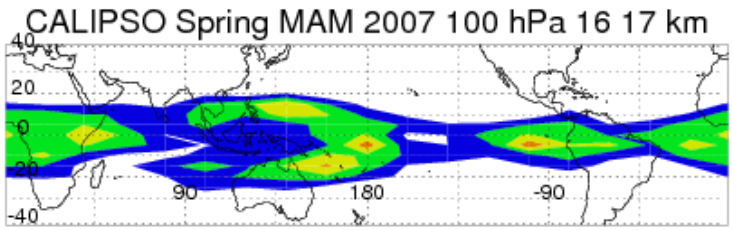
note scale: 0 – 18 %

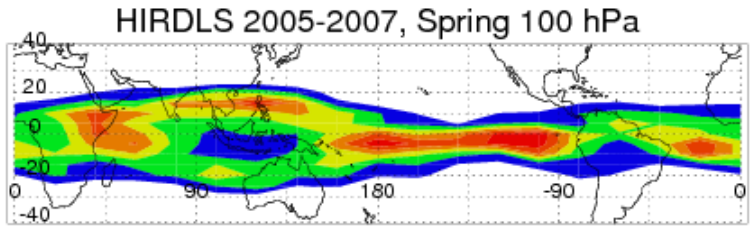
Seasonal Variations of Cirrus Layers – 100 hPa



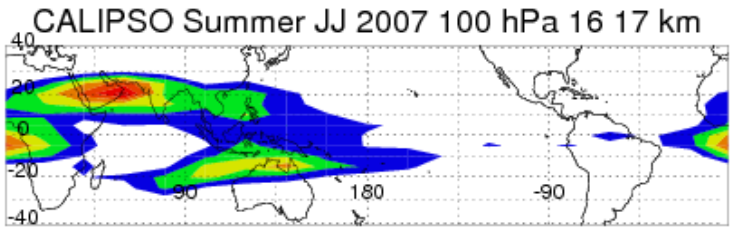


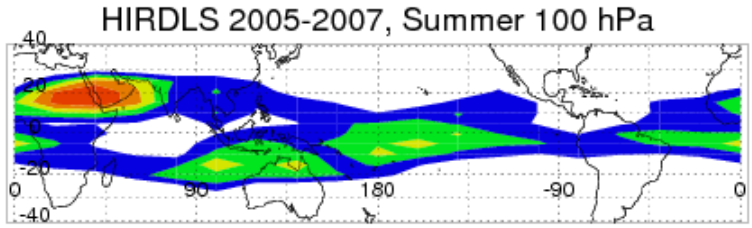
Winter



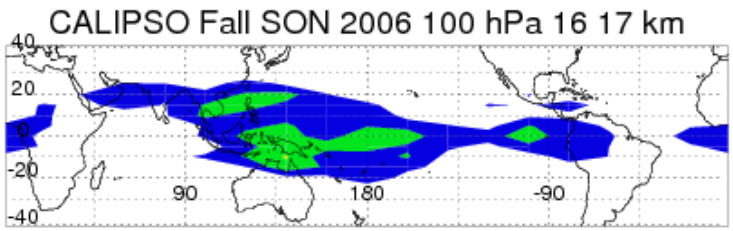


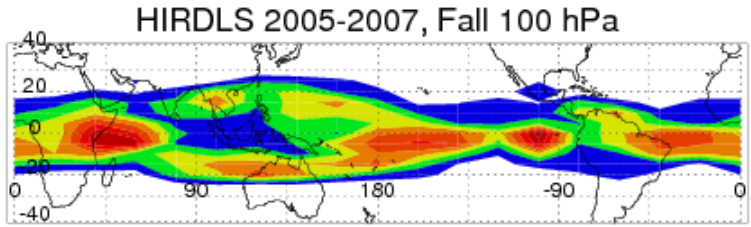
Spring



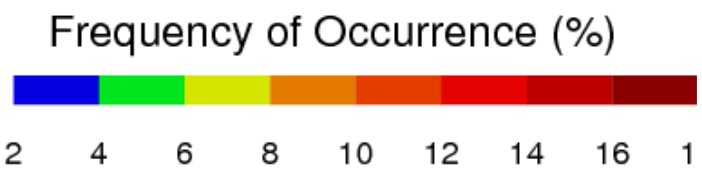


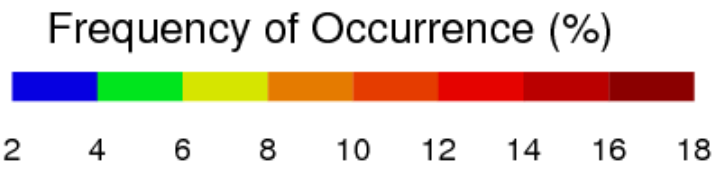
Summer



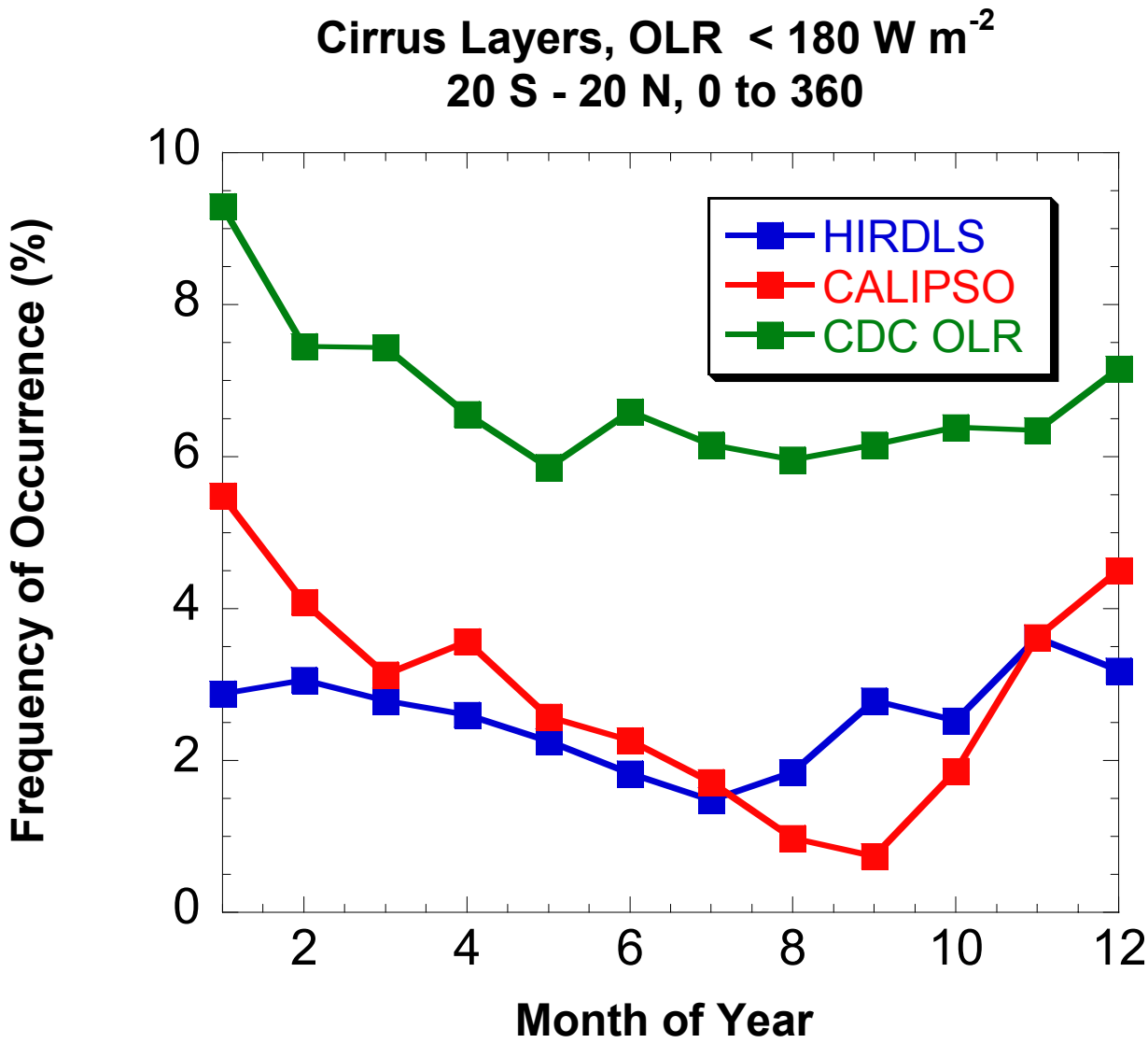


Fall

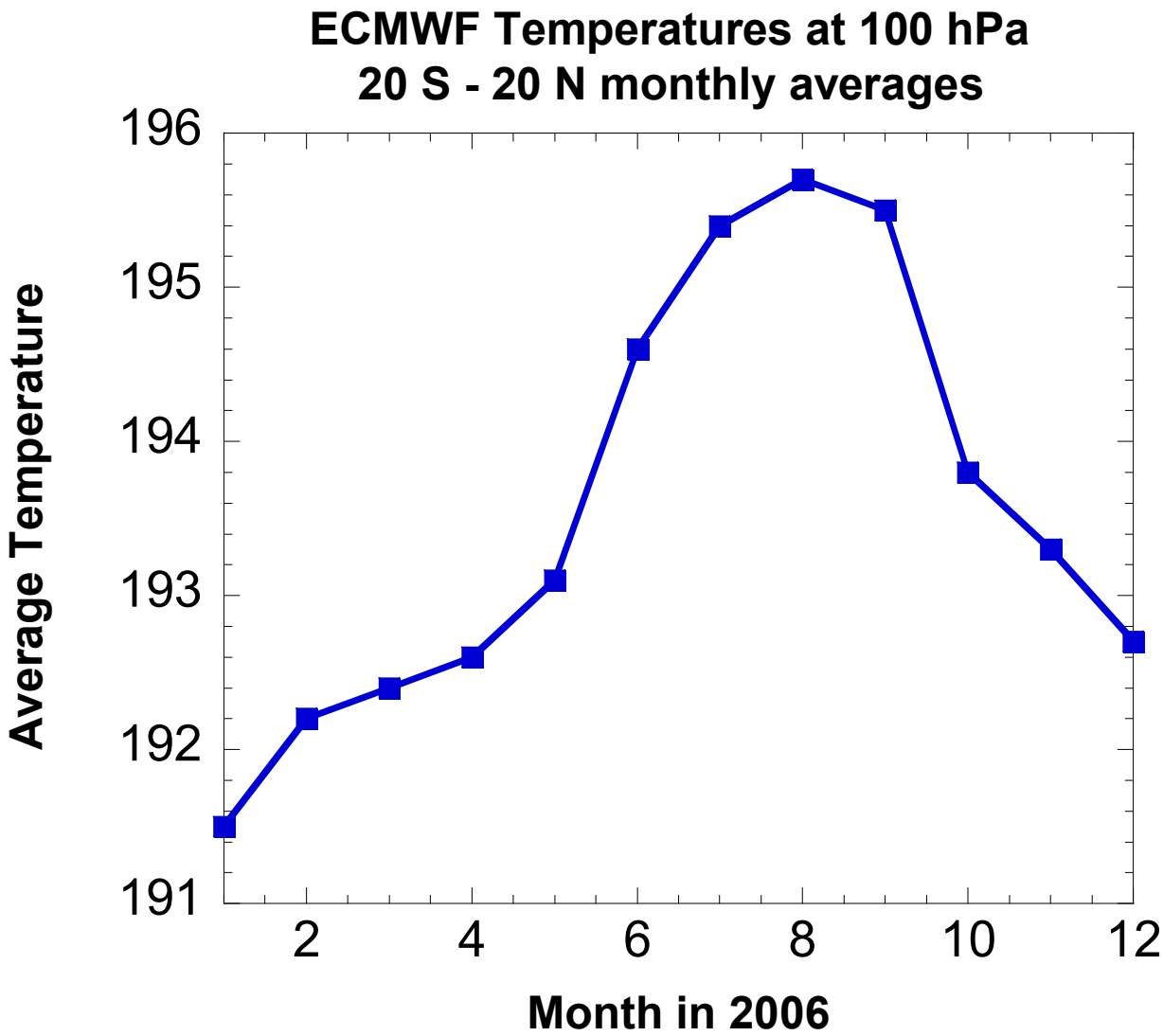




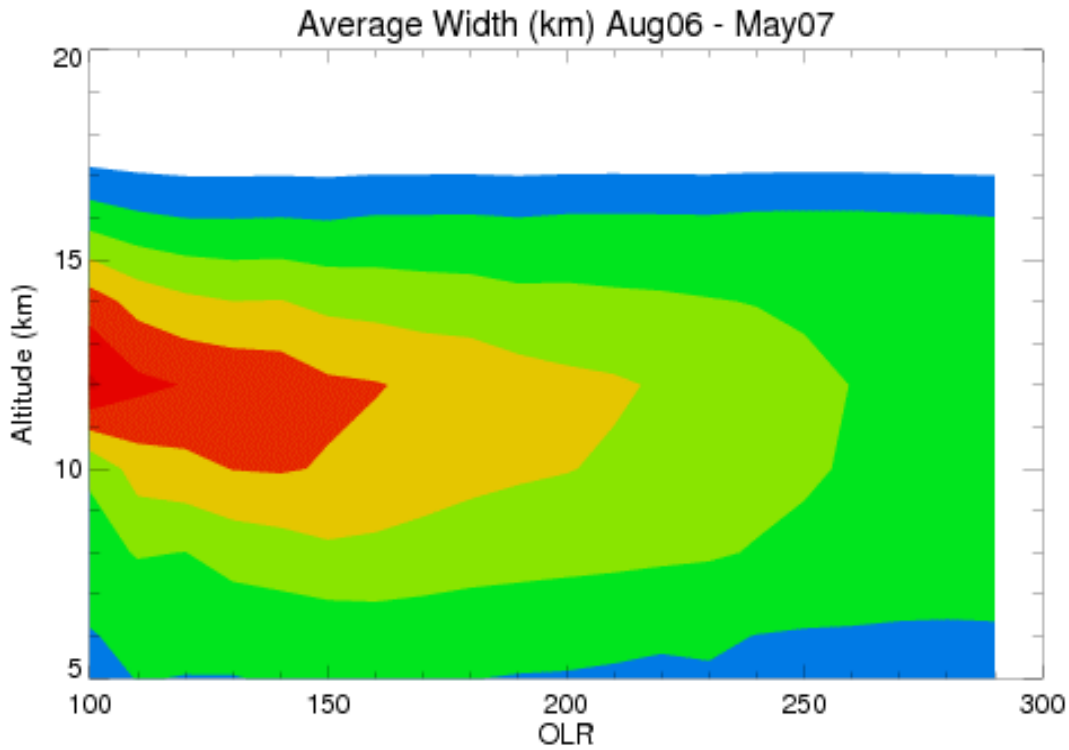
Cirrus Layers are Most Prevalent in Winter



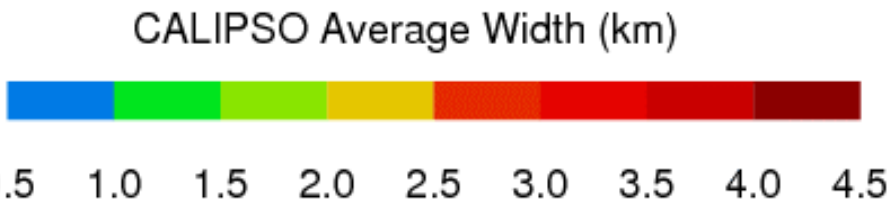
100 hPa Temperatures are colder in Winter



The Thinnest Cirrus Layers are Located Away from Deep Convection



deep convection



Laminar Cirrus Origins

What fraction of the time are the cirrus layers formed in-situ?

From previous work with HALOE cirrus and temperature observations
Ice frost point T_{ice} ~ 191 K near 100 hPa

Used ECMWF wind and temperature fields in 2006 to calculate the fraction of the time for which $T > T_{ice}$ along back trajectories at pressures < 121 hPa

5 day back trajectories

Used observations when the laminar cirrus > 200 km in horizontal extent

In situ formation fraction (T > 195 K):
~ 68%

Association with deep convection:
~ 14% of the trajectories have T < 195 K and OLR < 170 w m^{-2}

Conclusions

Cirrus layers are most prevalent
- **Away from the maritime continent**
- **Over the equatorial central Pacific**

Cirrus layers are most prevalent during winter

Cirrus vertical widths decrease away from deep convection

Cirrus layers are produced by in-situ processes ~ 68% of the time near 100 hPa when the horizontal scale of the cirrus > 200 km